A portable muon telescope based on small and gas-tight Resistive Plate Chambers

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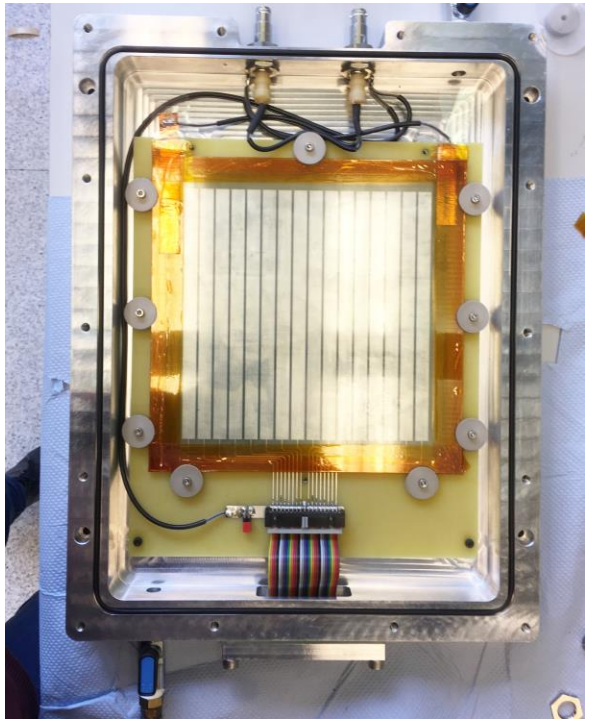


UCLouvain

A gaseous detector : Resistive Plate Chambers

Basic principle of operation

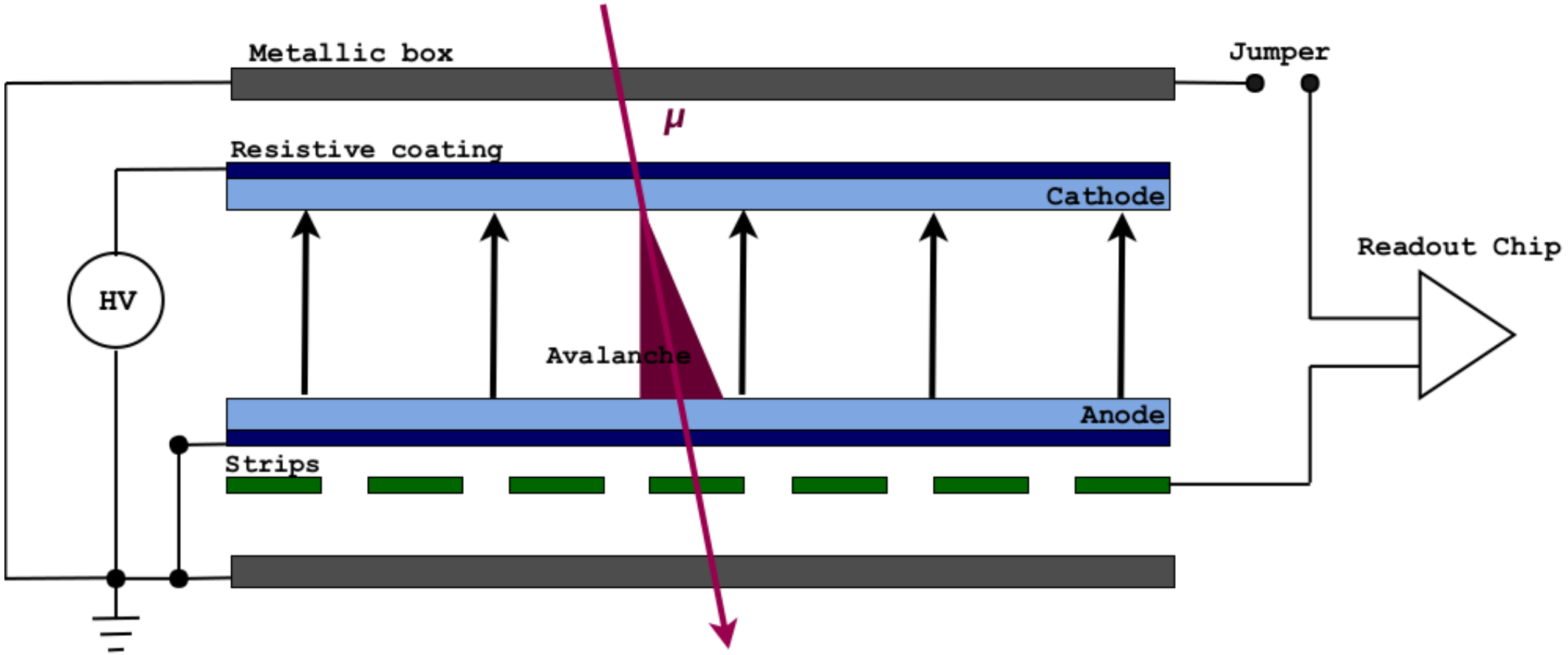
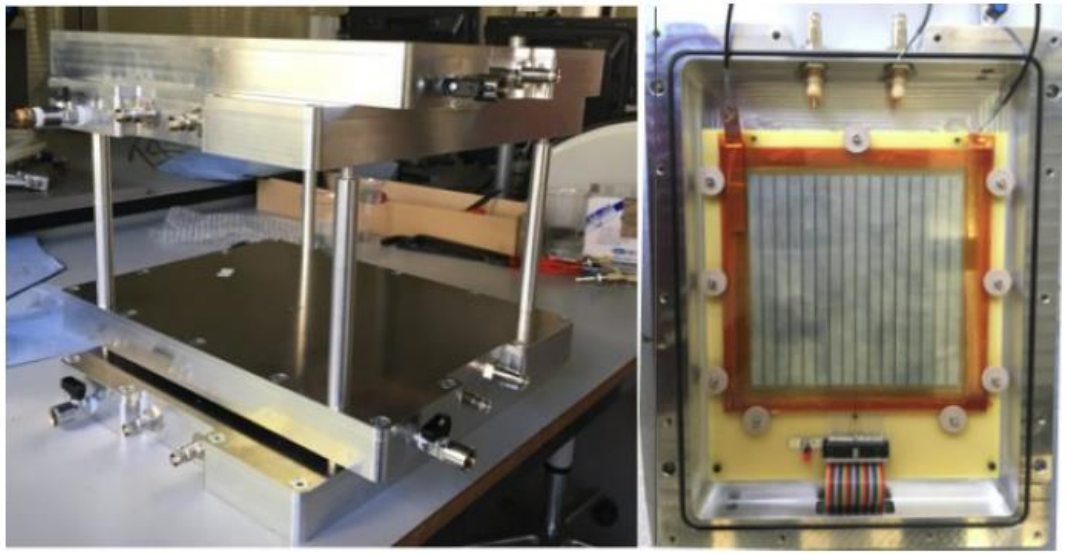


Figure: Schematic view of an RPC. An ionizing particle passes through the gas gap and an electron avalanche is initiated towards the anod

First prototype telescope

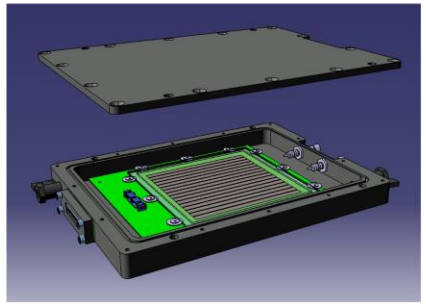


(with RPC team at UGent, Belgium)

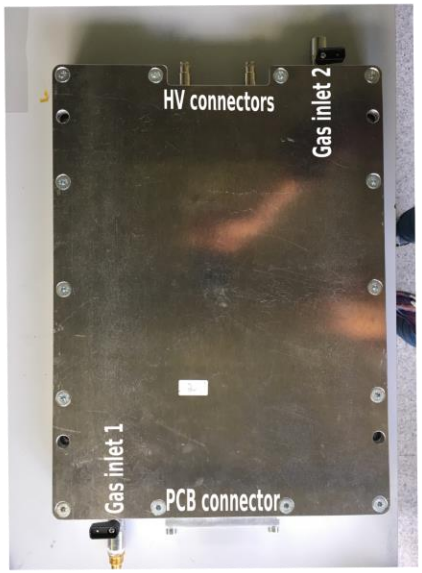
- First full prototype built @ UCLouvain with UGent's support
  - 4 planes (x-y, x-y)
  - Eventually we will go to larger strip density (see later)
- Design principle: must be portable
  - Sealed; particular care in making gas-tight boxes (10-9 mbar l/s)
  - Small (active area: 16x16 cm2)
  - Total weight including the electronics: ~50 kg
  - Robust
  - Modular geometry

Construction: Mini g-RPCs prototype

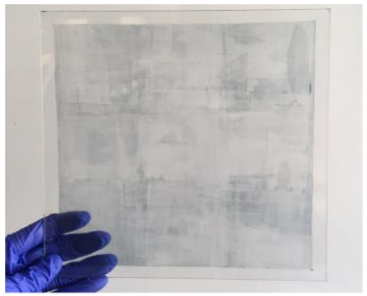
Mechanical design @Nicolas Szilazi



Aluminum box

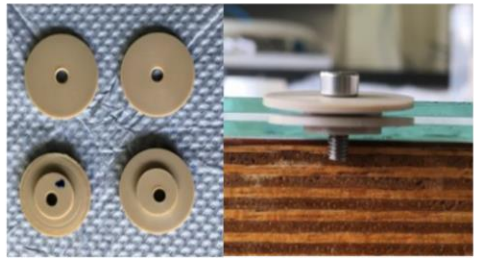


Resistive coating



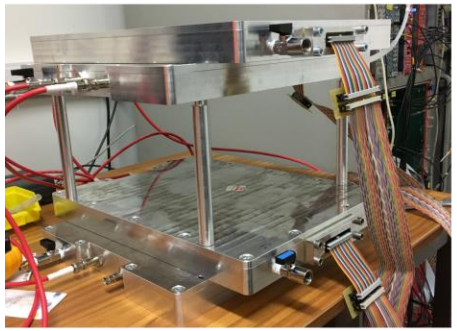
Inside chamber

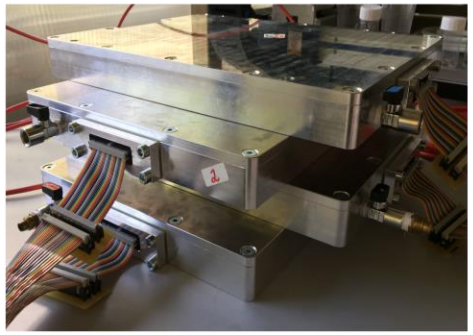
Spacers



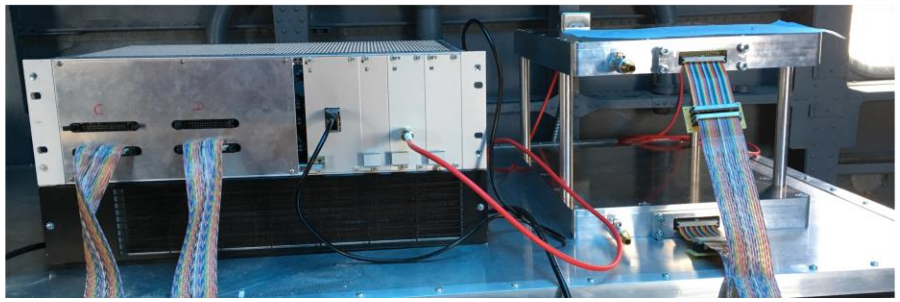
Vacuum tests

Telescope configurations





Detectors assembled with readout and high voltage electronics system



UCL to Mars

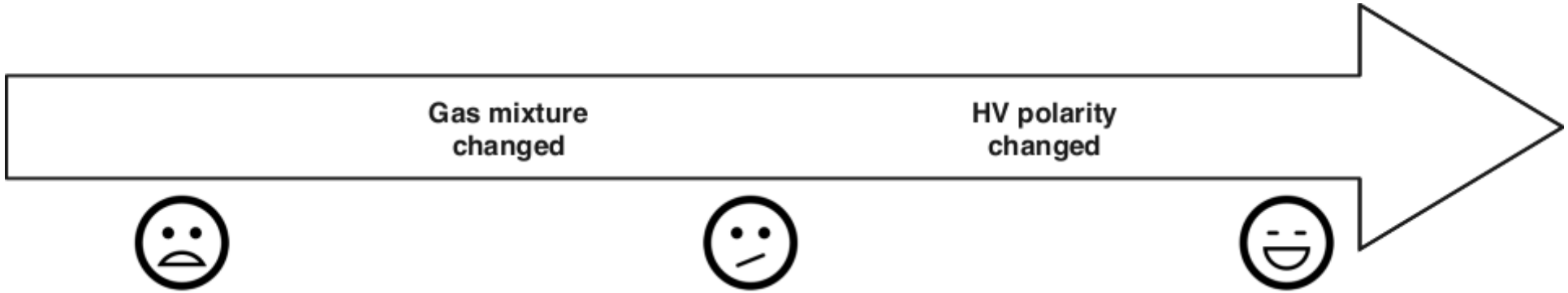
Annual life-on-Mars simulation in the Utah Desert; students propose scientific experiments that would make sense in a martian mission

Implicit test of robustness: those two RPCs were shipped to a remote location and came back, still functioning as before

<u>What (do we need) if we could muograph the Red Planet ?</u>

More information : https://ucltomars.org

Data collection: Learning by trial and error



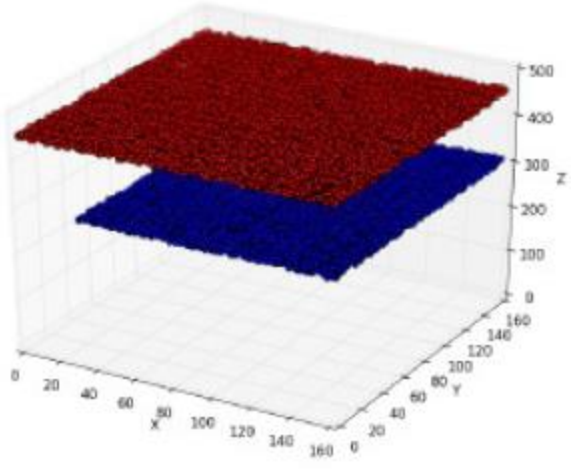


Figure: @MDRS - 4.5kV & th 100

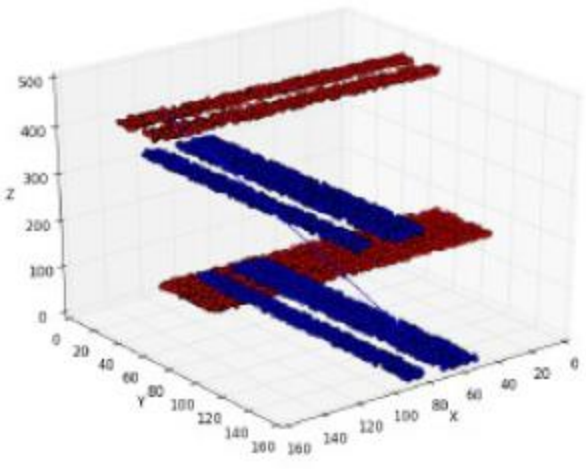


Figure: @UCL with negative HV - 6.8 kV & th 100

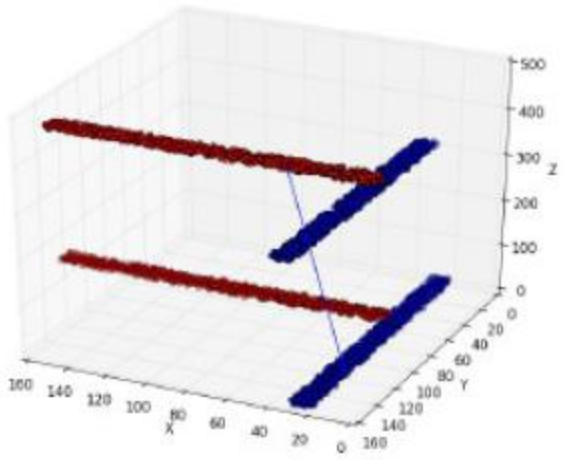
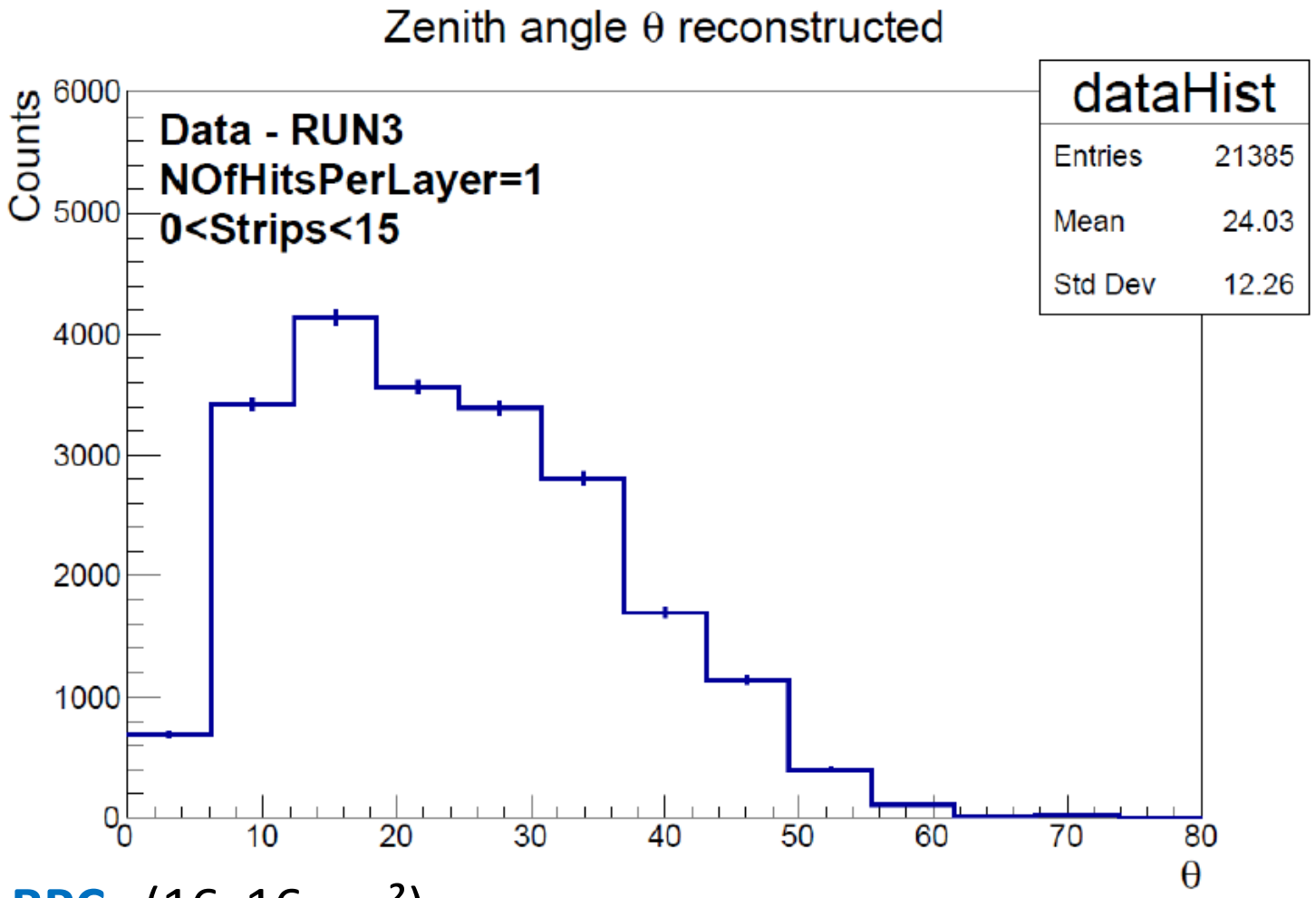


Figure: @UCL with positive HV - 6.6 kV & th 105

Track reconstruction : 7 days run



UCL mini gRPCs (16x16 cm²)

4 planes & height depending on detectors configuration (15-30 cm)

Next steps (with RPC team at UGent, Belgium)

- Long-term stability tests for **sealed** chambers
- Optimization of chamber **construction**: new coating procedures for the glass electrodes based on inkjet printing and sputtering techniques
- Optimization and simplification of **gas parameters**: ecofriendly, monogasses
- Improvement of **spatial resolution**:

  1) Thinner strips: up to a factor 10 is potentially achievable

  2) High-granularity, low power consumption electronics with the MAROC3 64-channel ASIC (with LIP, Portugal)

  3) Codification / grouping of readout structures to reduce by factor 10 the number of front-end electronic channels

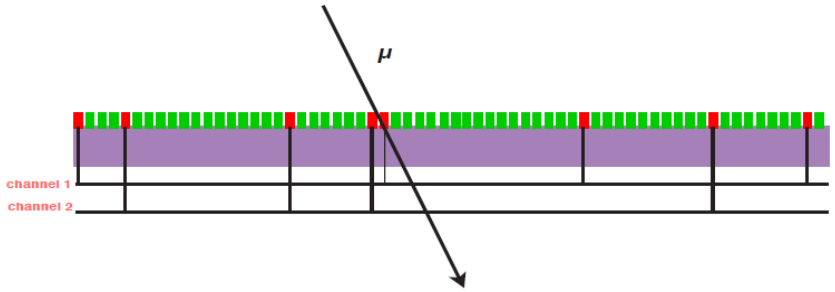


Figure : Genetic multiplexing

Another UCLouvain student of physics is scheduled to participate in May 2019; he plans to bring our next prototype there !

Summary

- Construction of a set of 4 mini-gRPCs (UCL)
- Data collection (Utah Desert + UCL): Modifications of the setup following the problems encountered
- Data analysis : - High voltage and thresholds operating points

  - Hits pattern

  - Track reconstruction

=> **The mini-gRPCs prototype works !**

=> It is compact, portable, gas tight and robust

=>Still many things to investigate with it +upgrades needed

=> After some improvements, we could be able to perform muography

References

- "A portable muon telescope based on small and gas-tight Resistive Plate Chambers", S. Wuyckens, A. Giammanco, P. Demin, E. Cortina Gil, Phil. Trans. R.Soc. A 377 (2018) 20180139.
- "Genetic multiplexing and first results with a 50x50 cm2 Micromegas", S.Procureur, R.Dupré, S.Aune, NIM A, 729:888, 2013.